Clinically Applicable Model-Based Pulse Contour Analysis Method for Stroke Volume Estimation

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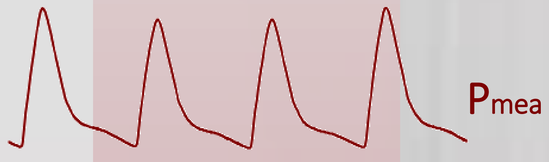
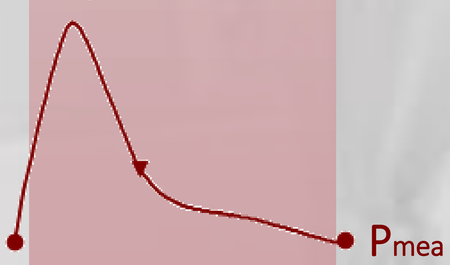
Measured Signals

ECG

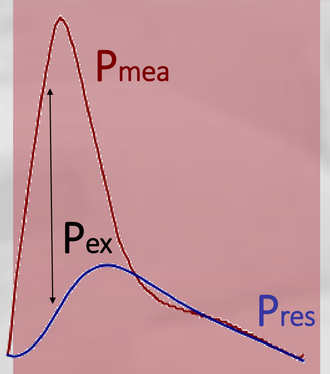
Femoral Blood Pressure



Beat Separation & End Systole Detection



3 Element Windkessel Model



Beat to Beat Flow waveform & Stroke Volume estimation

Motivation

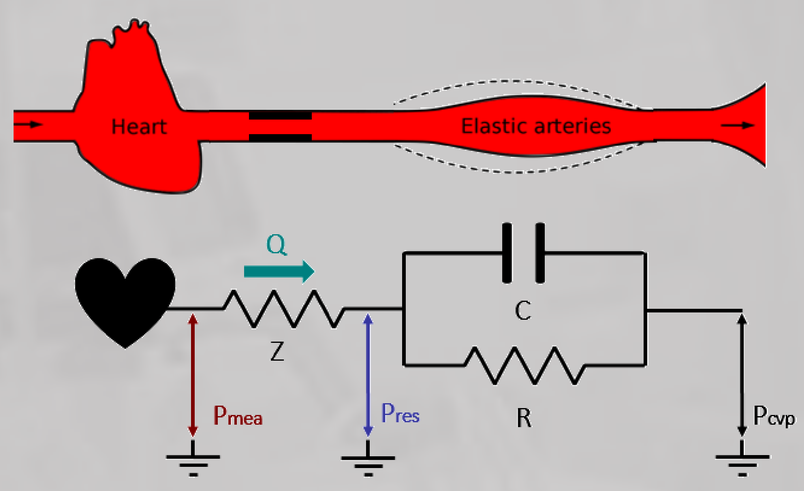
Hemodynamic management in ICU is challenging:

- stroke volume (SV) & cardiac output not directly measurable
- variable & complex patient response to therapy
- ambiguity in choosing the best treatment strategy

Model based hemodynamic management:

- Non-additionally invasive SV estimation
- patient-specific, time-varying parameters account for intra- & inter-patient variability
- clinical protocols based on response of cardiac output to intervention

3 Element Windkessel Model



$$Q = Z \times (P_{mea} - P_{res}) = Z \times P_{ex}$$

Arterial pressure waveform P_{mea} divided into:

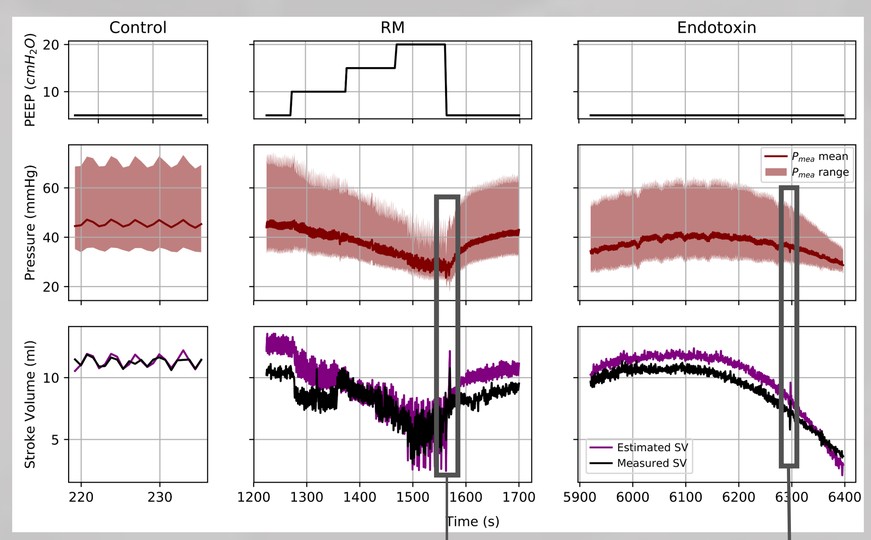
- P_{res}, pressure that stretches arteries
- P_{ex}, pressure proportional to flow

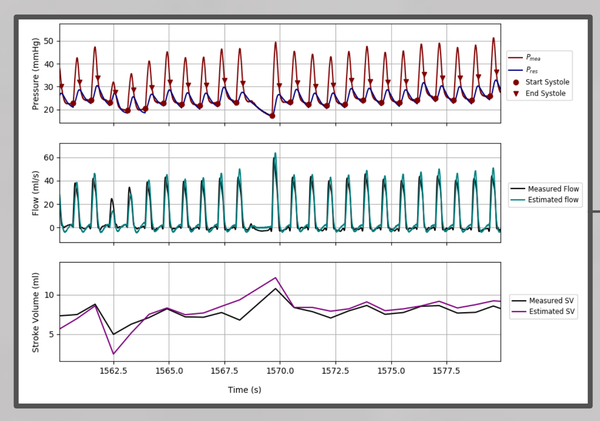
Parameters found using pulse waveform shape & calibration

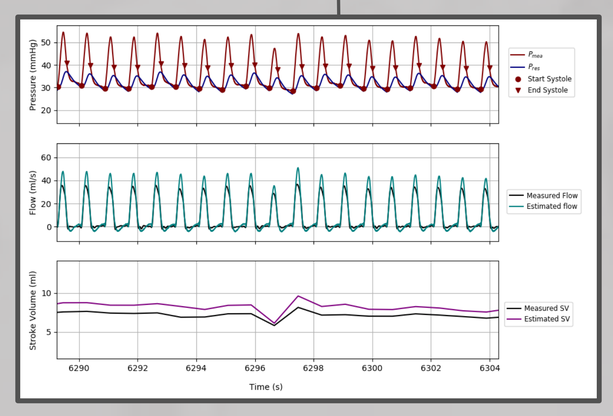
Results

Pig studies
- Aortic flow probe for validation
- Recruitment manoeuvres & Endotoxin to change SV

Model captures changes in SV well during interventions







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